



# Hadron Rejection Results

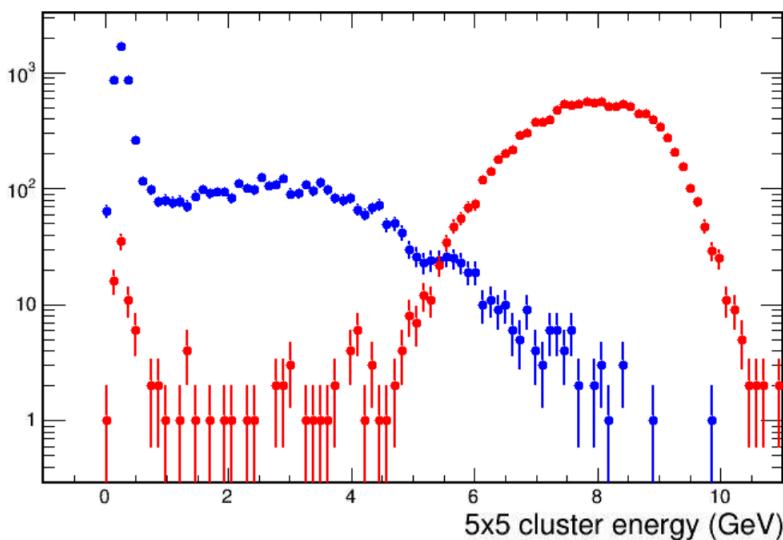
Jin Huang (BNL)

# From last meeting:

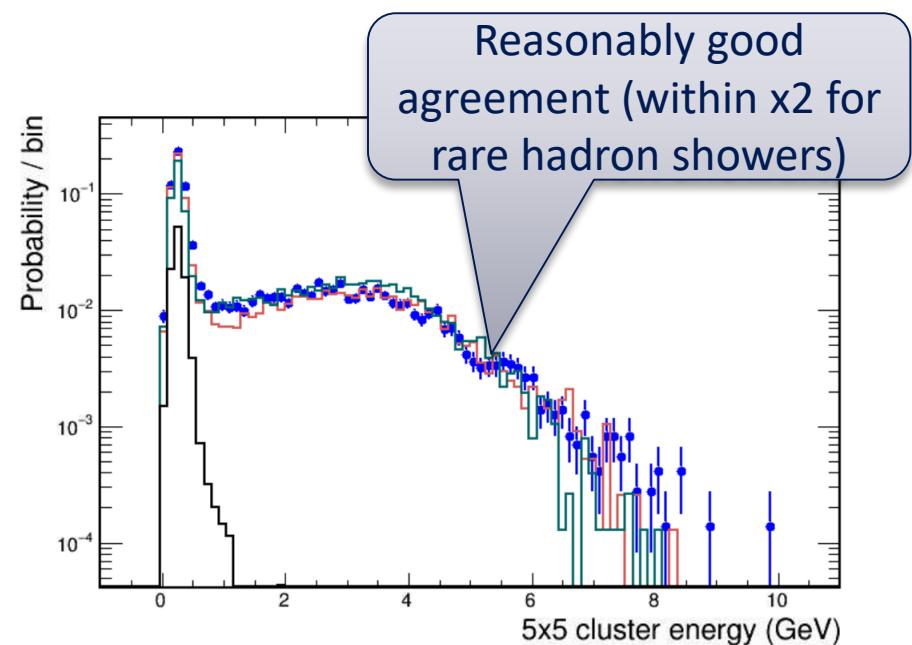
Final energy scan on UIUC 21

0 degree rotation, 0 degree tilt, 5x5 hodoscope cut

[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)

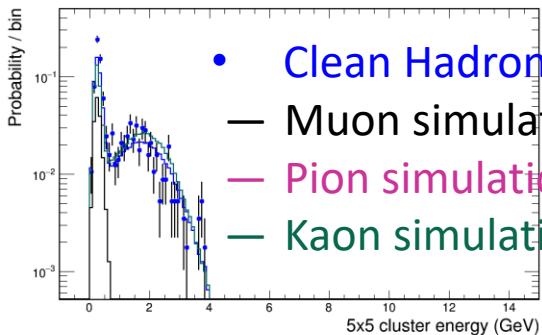


- Clean Hadronic/Muon data
- Clean Electron data

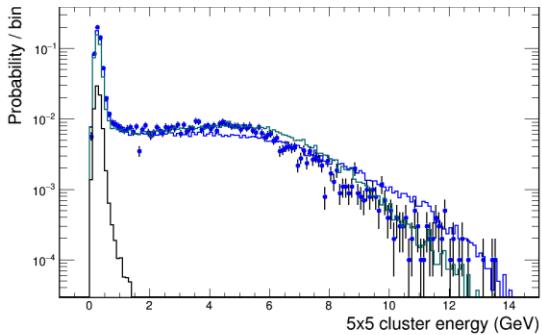
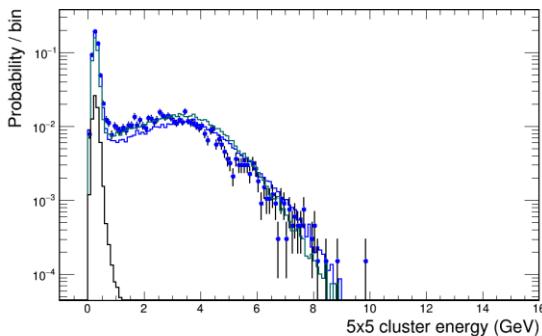


- Clean Hadronic/Muon data
  - Muon simulation \* 10%
  - Pion simulation \* 90%
  - Kaon simulation \* 90%

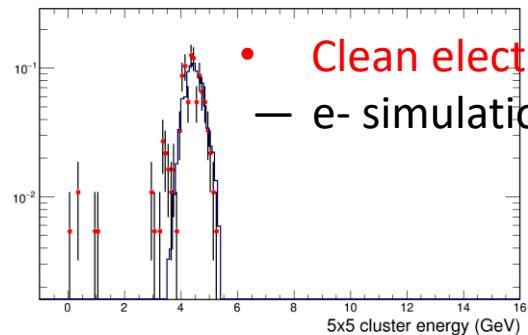
# Energy scale calibration for simulation



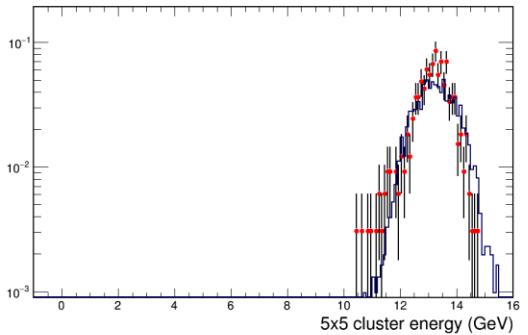
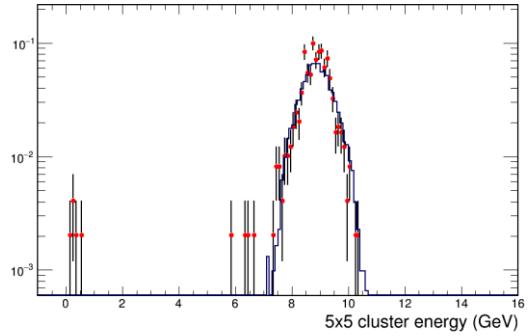
- Clean Hadronic/Muon data
- Muon simulation \* 10%
- Pion simulation \* 90%
- Kaon simulation \* 90%



Non-electron data  
5x5 hodoscope cut



- Clean electron data
- e- simulation

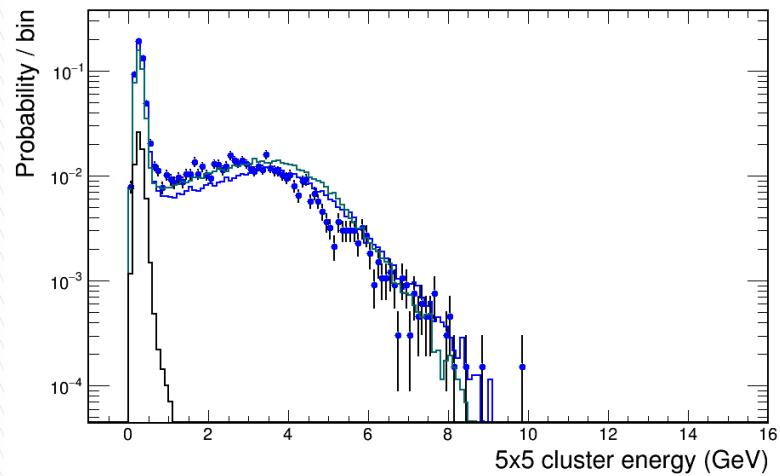
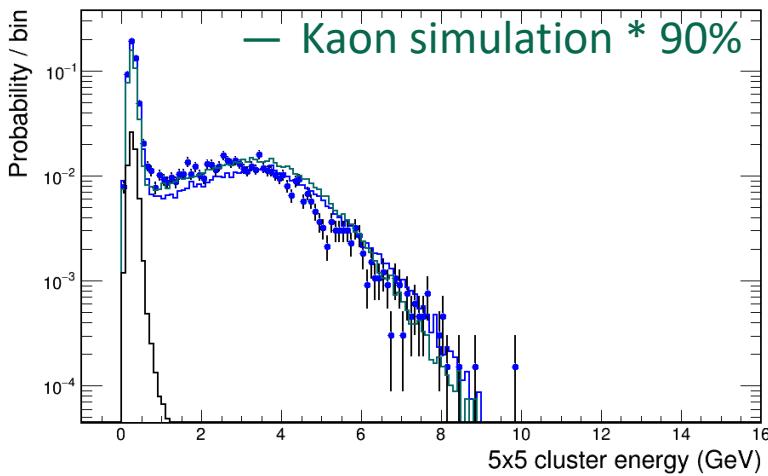


Electron data  
1x1 hodoscope cut

# Physics list comparison

## 8 GeV non-electron data, 5x5 hodoscope cut

- Clean Hadronic/Muon data
  - Muon simulation \* 10%
  - Pion simulation \* 90%
  - Kaon simulation \* 90%

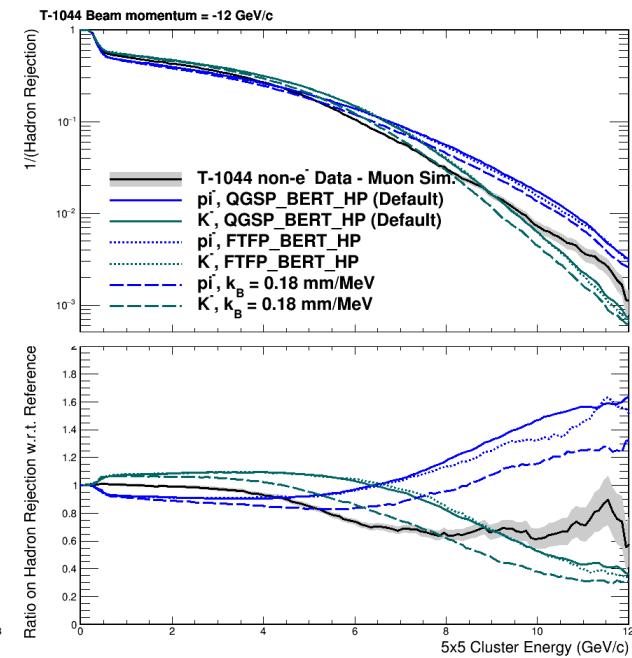
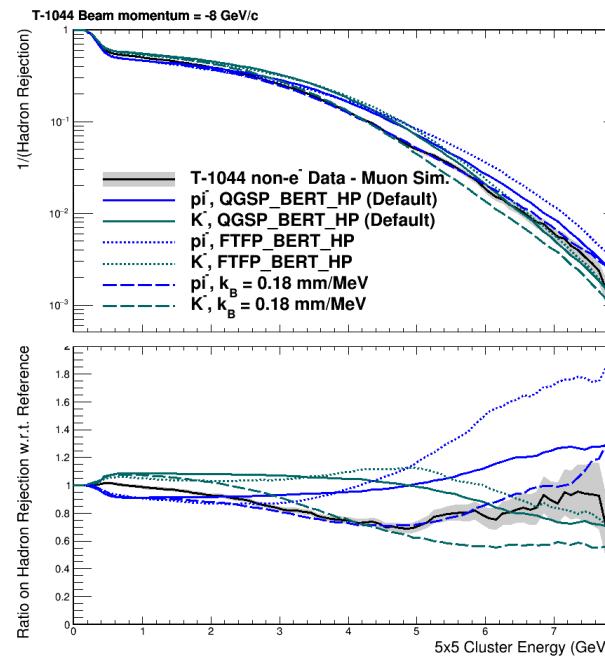
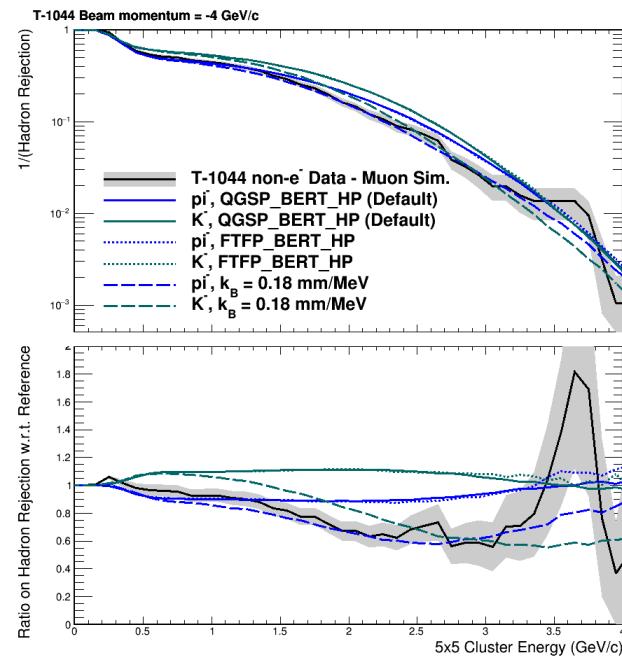


QGSP\_BERT\_HP

QGSP\_BERT

# New plots to quantify simulation

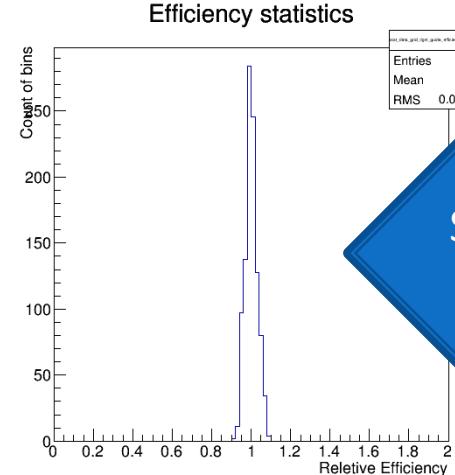
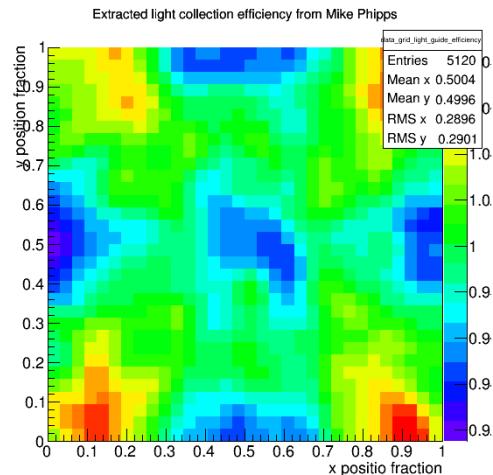
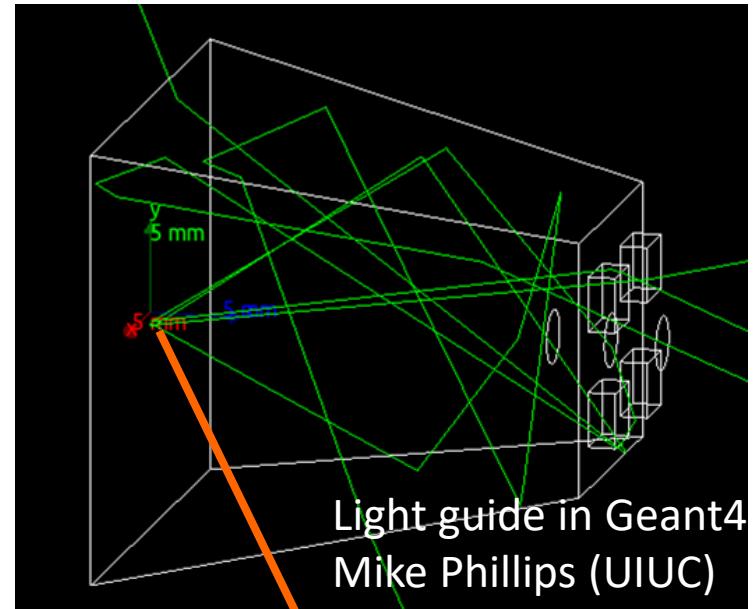
- ▶ Default: QGSP\_BERT\_HP +  $k_B=0.079$  mm/MeV(ZEUS)
- ▶ Physics list tests:
  - \*\_HP list do not differ much
  - FTFP\_BERT\_HP work worse.
- ▶ Birk constant:
  - $k_B=0.151$  (CALICE measured)
  - $k_B=0.18$  (CALICE adjust to default Geant4 stepping)
  - Reference: Birks' Coefficient of the AHCAL Scintillator, Alexander Tadday (CALICE), University of Heidelberg



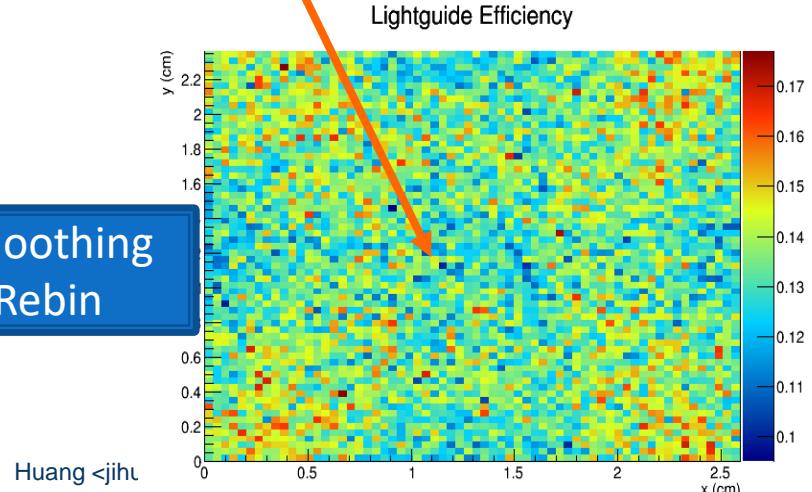
# Extra information

»»

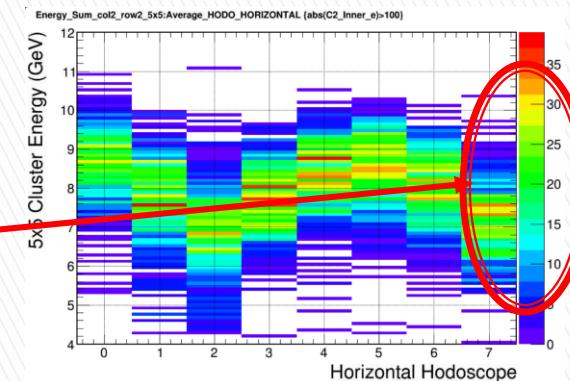
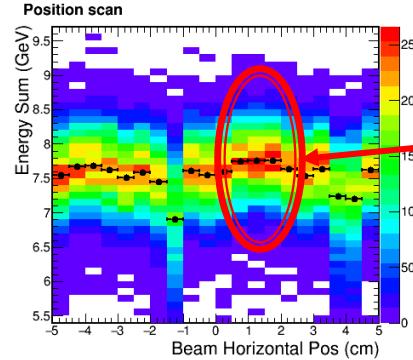
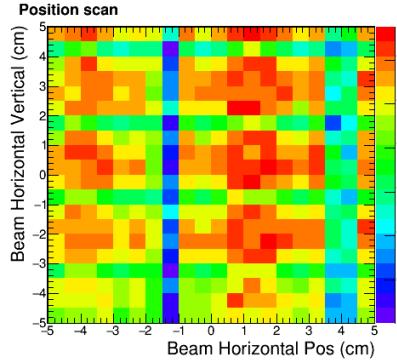
# Past simulation - Light guide model



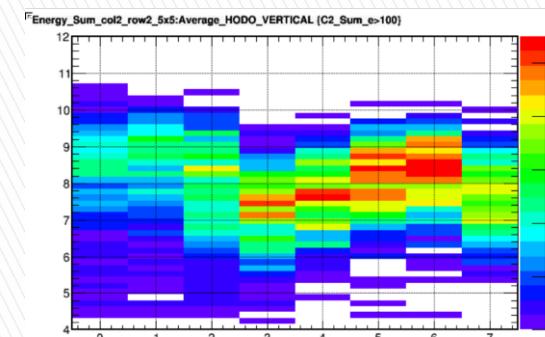
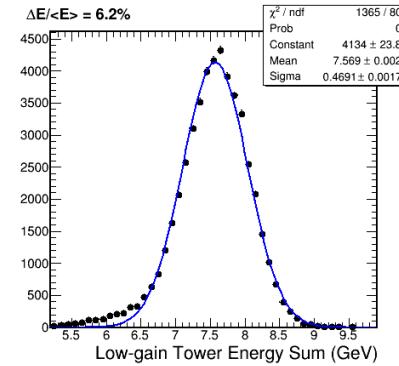
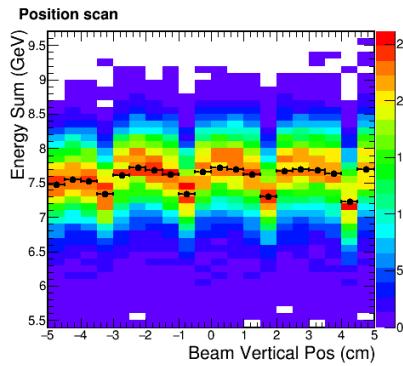
Smoothing  
Rebin



# Past simulation - Position dependence: Sim VS data disagree



Horizontal hodo-scope (0.5 mm/counter)



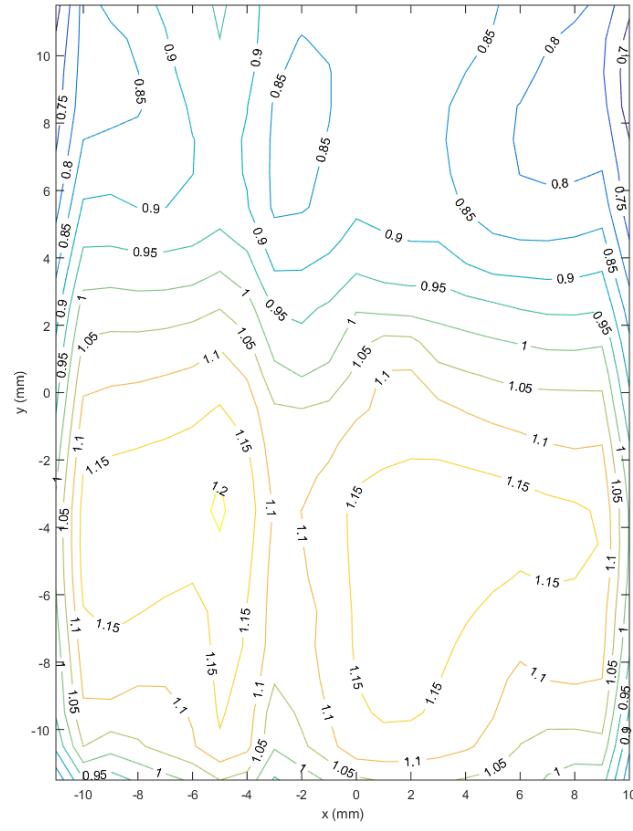
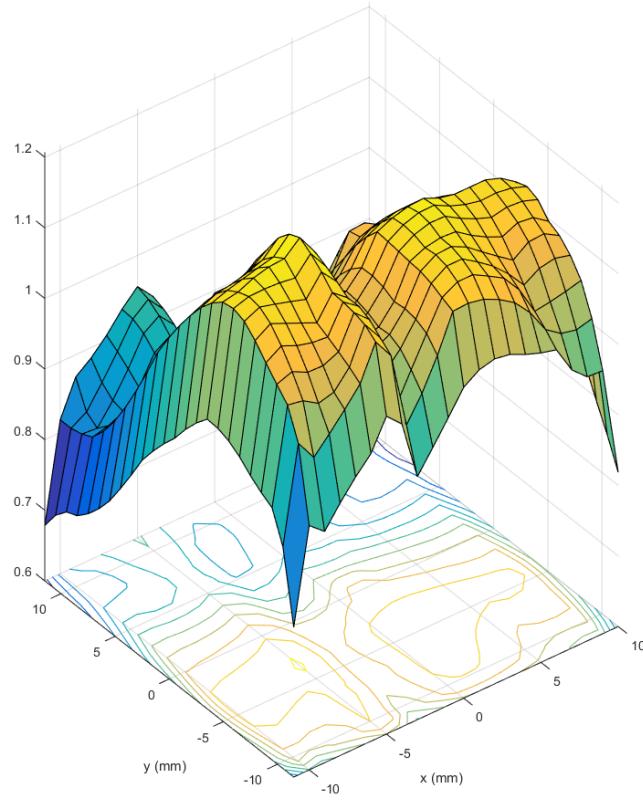
Vertical hodo-scope (0.5 mm/counter)

Simulation with simulated  
light guide collection eff.

T1044 Data  
Run 2609, up tilt 5 degree, 8 GeV electron

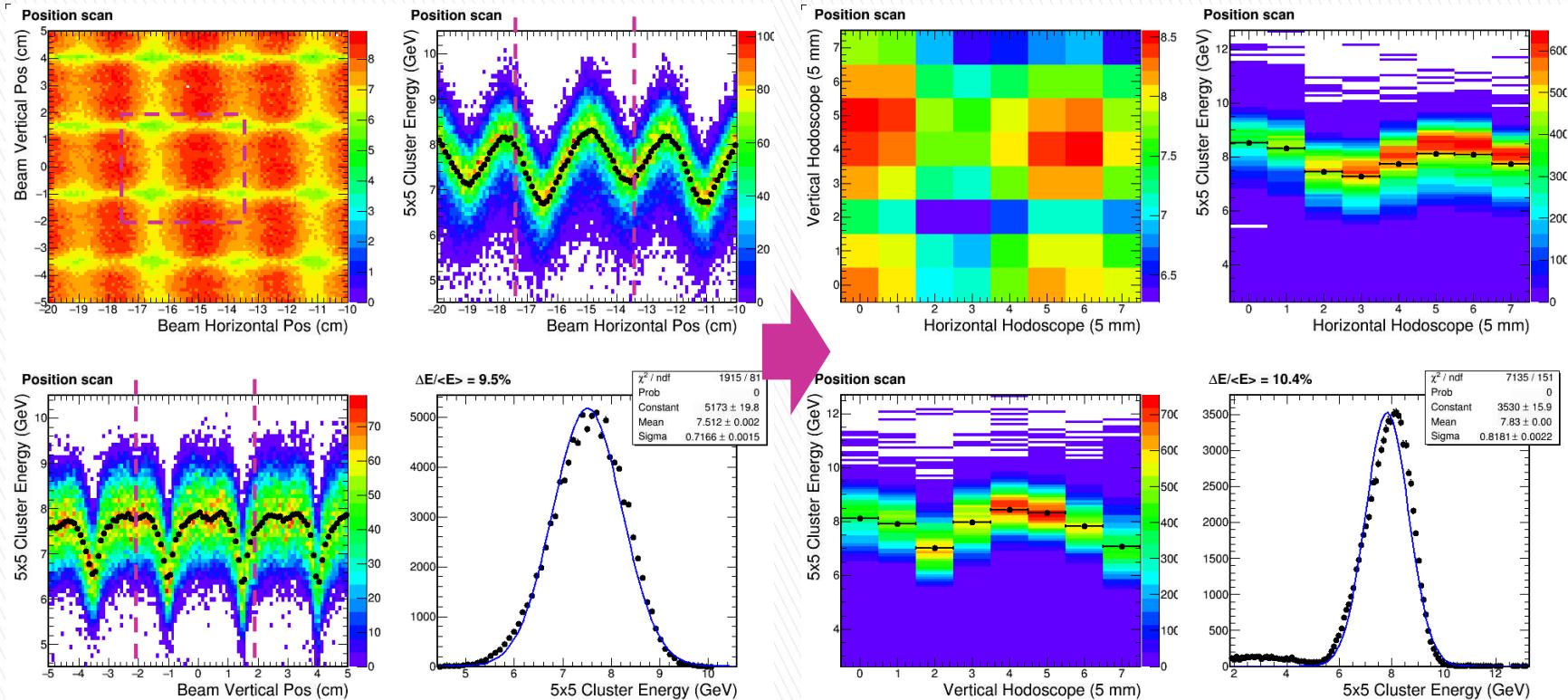
# Measured light collection efficiency

## From Sean Stoll, tower2 light guide



# New sim VS data 1

## 10 degree rotation, UIUC 21, 8 GeV



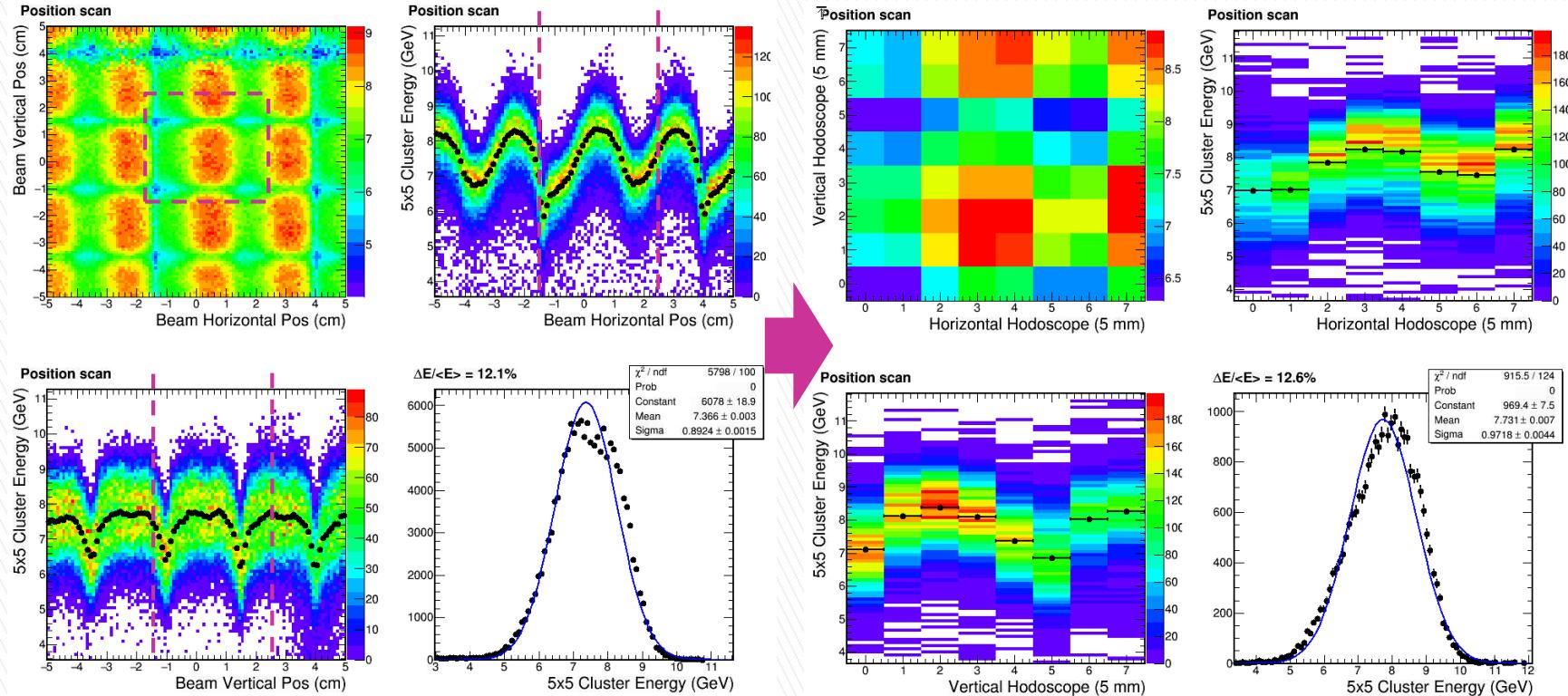
simulation + measured light collection efficiency by Sean

T-1044 Data

[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28UIUC\\_centered.2C\\_Tower\\_21.2C\\_350k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28UIUC_centered.2C_Tower_21.2C_350k_Events.29)

# New sim VS data 2

## 0 degree rotation, UIUC 21, 8 GeV



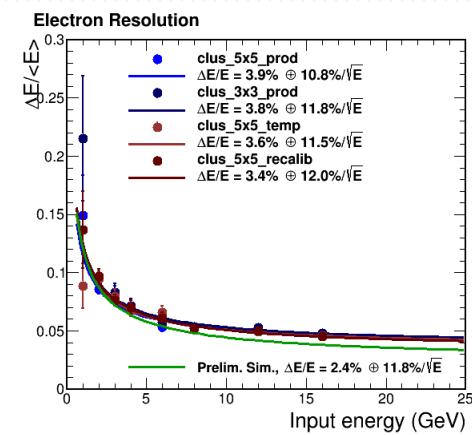
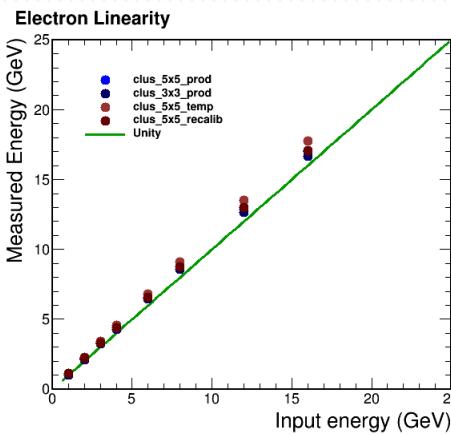
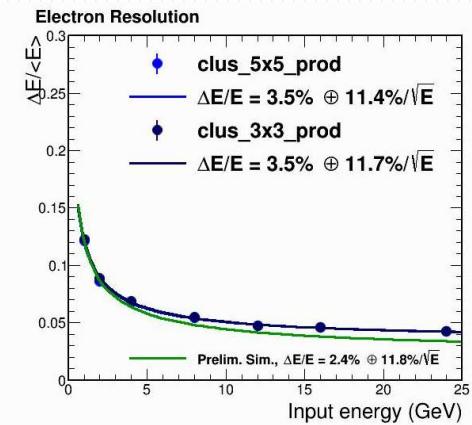
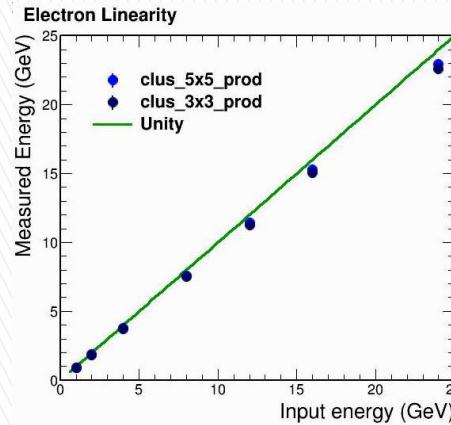
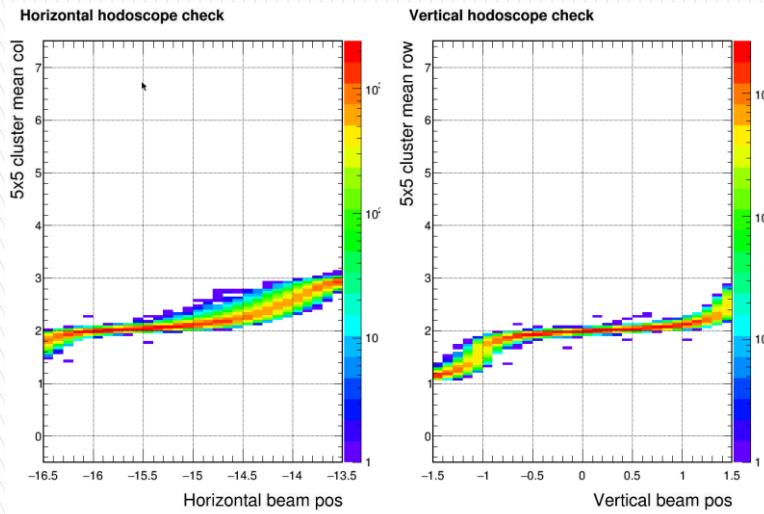
simulation + measured light collection efficiency by Sean

T-1044 Data

[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)

# New sim VS data with 10 degree rotation

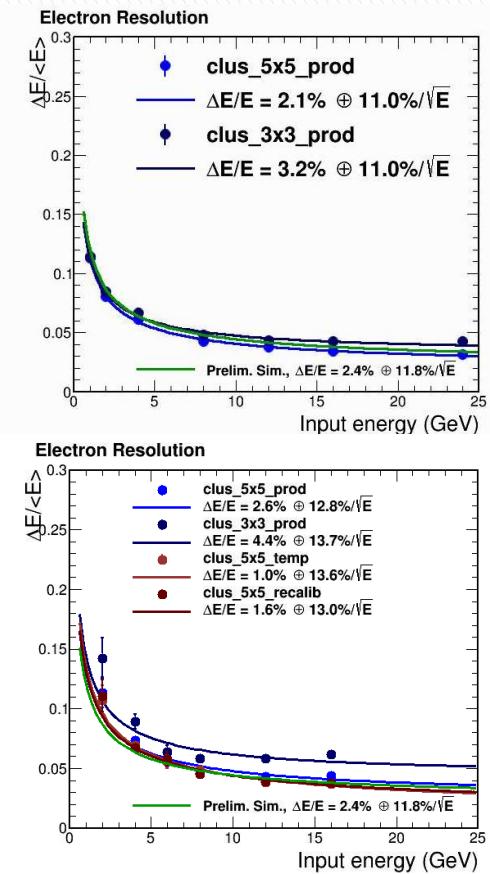
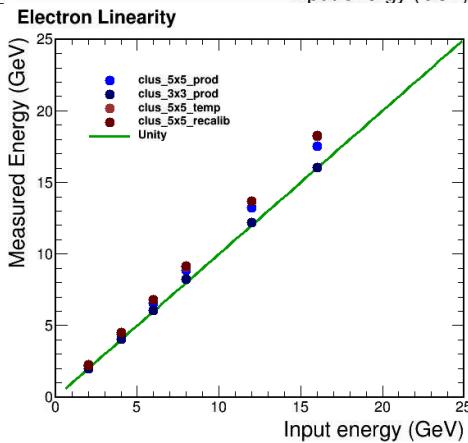
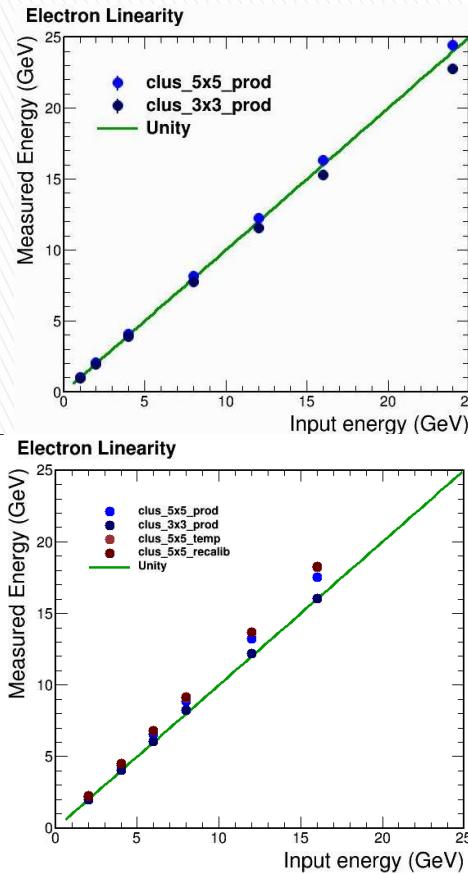
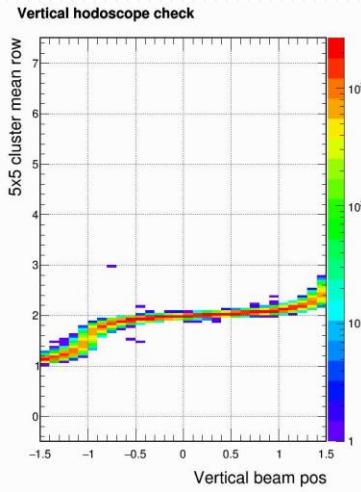
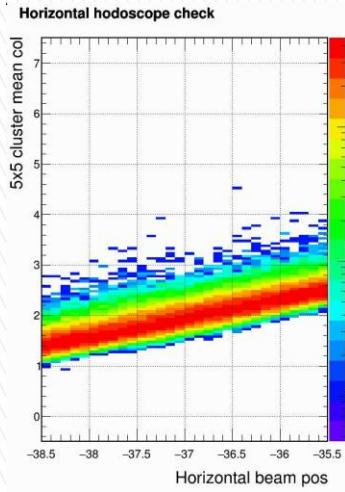
## UIUC 21 second scan



Cluster position VS beam position (sim)

Linearity and resolution  
Top: simulation VS bottom: data

# New sim VS data with 45 degree rotation, UIUC 21 high eta scan

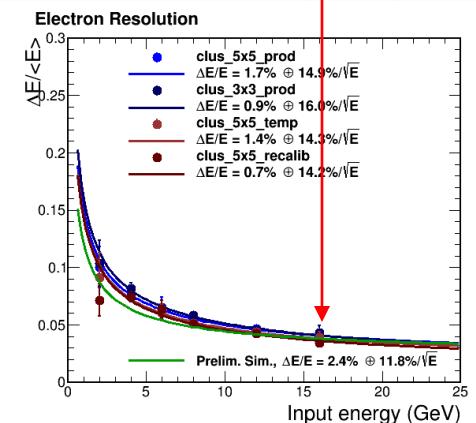
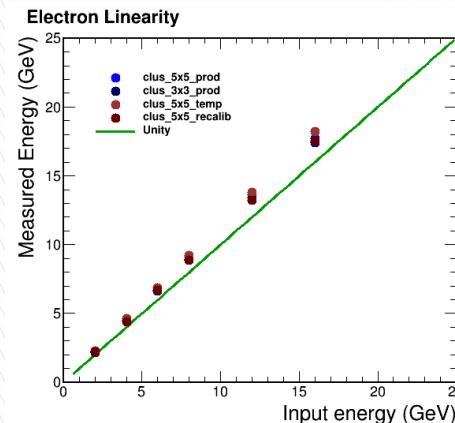
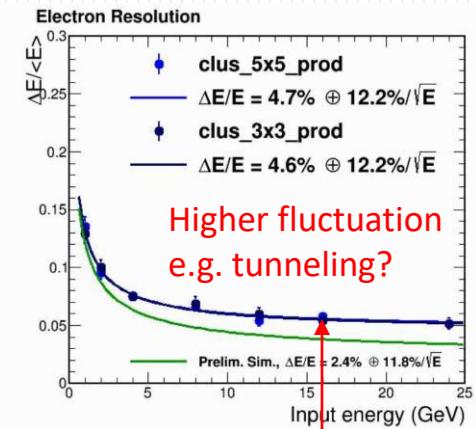
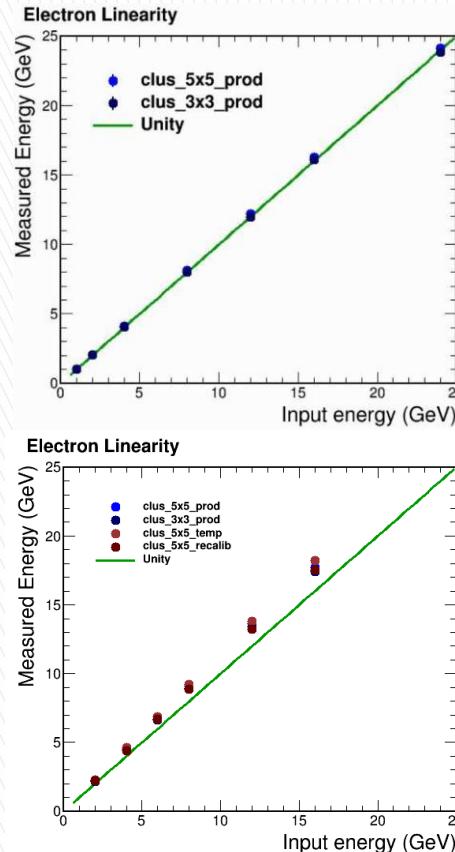
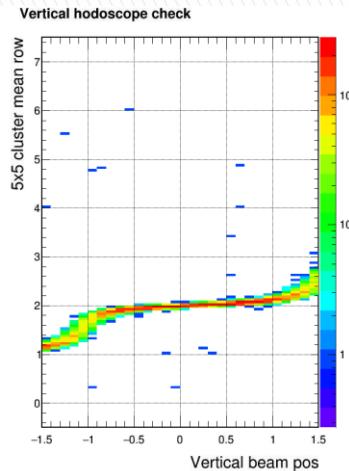
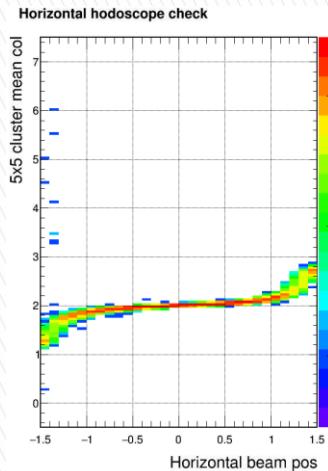


Cluster position VS beam position (sim)

Linearity and resolution  
Top: simulation VS bottom: data

# New sim VS data with 0 degree rotation

## Final energy scan, 0 tilt, UIUC 21



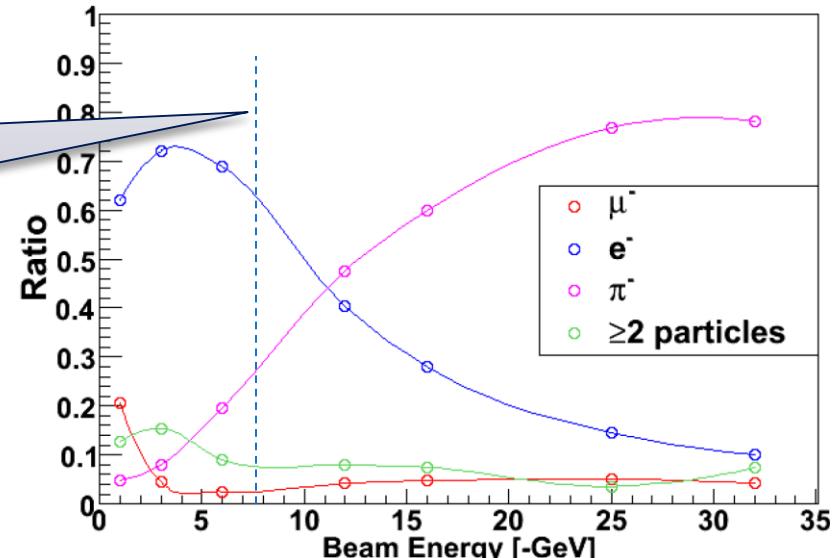
Cluster position VS beam position (sim)

Linearity and resolution  
Top: simulation VS bottom: data

# Hadron response

- ▶ Hadron response require probing rare hadronic showers that extends into the electron peak in energy response.
- ▶ Requires
  - High Cherenkov efficiency for electron: runs with Cherenkov pressure matching
  - Low momentum spread: with proper collimator setting
  - Low background: tight cut on hodoscope that only one finger fires per orientation

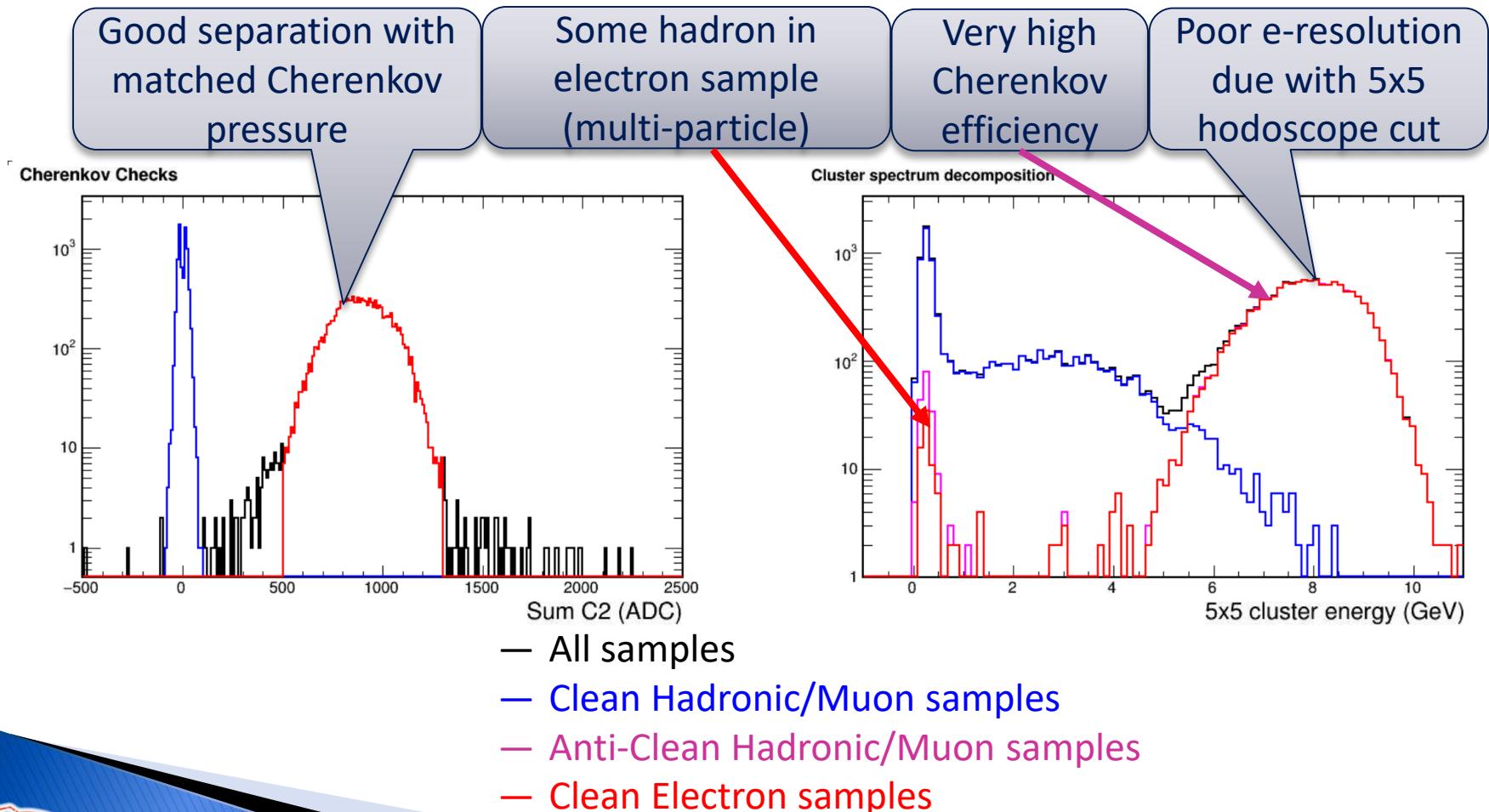
In non-electron -  
8GeV/c samples:  
~10% muon and 1/3  
multi-particles



# Final energy scan on UIUC 21

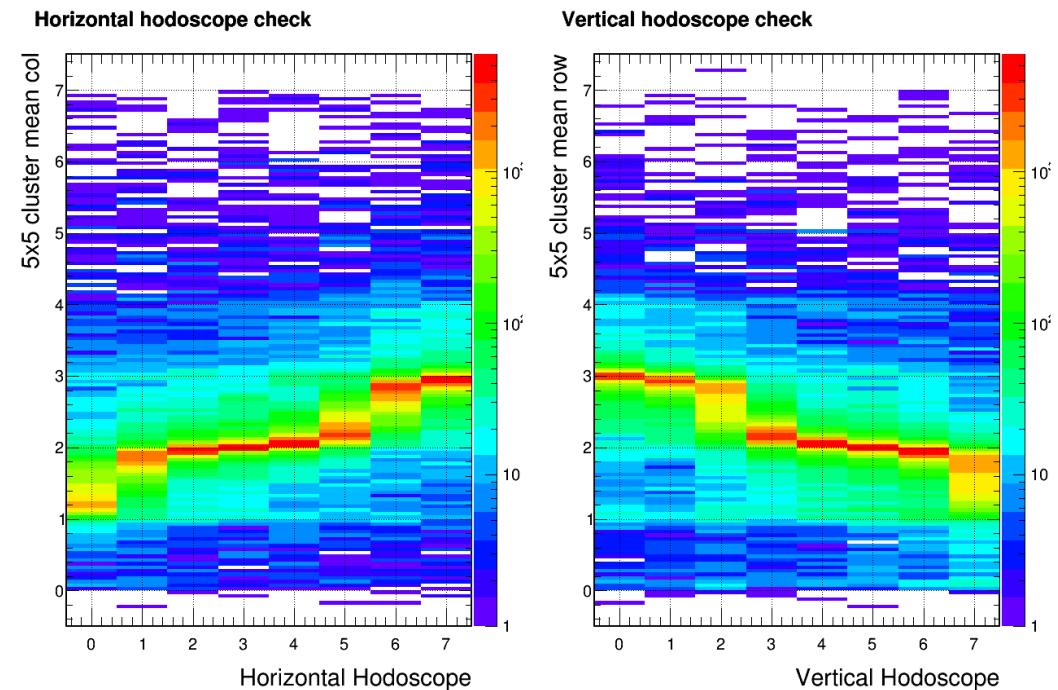
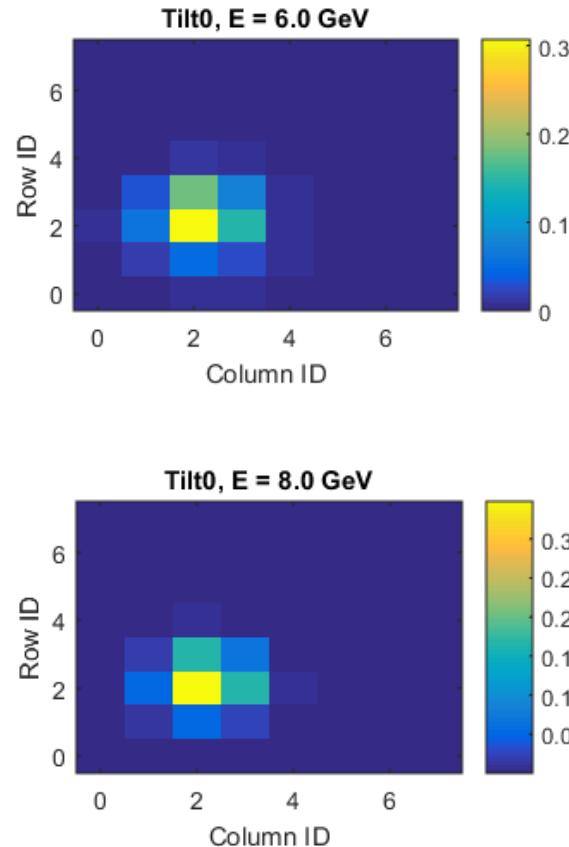
## 0 degree rotation, 0 degree tilt,

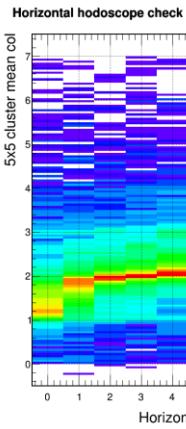
[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)



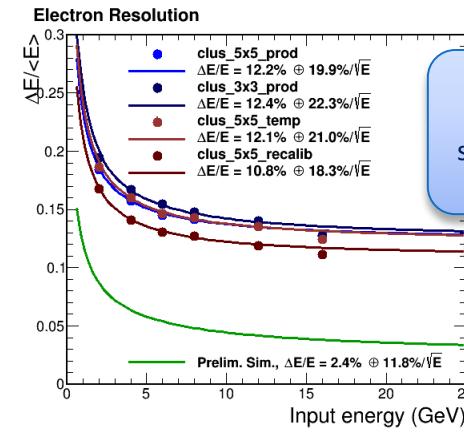
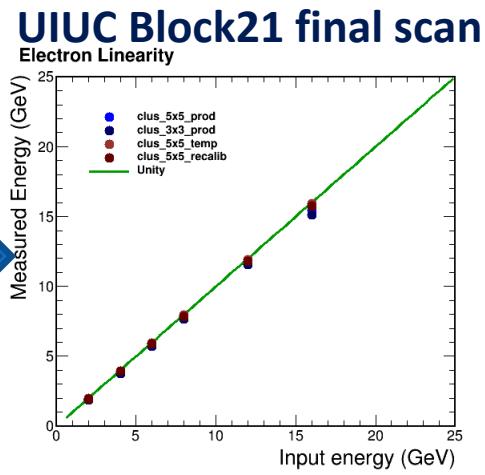
# Apply to Final Energy Scan, 0 tilt

[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)

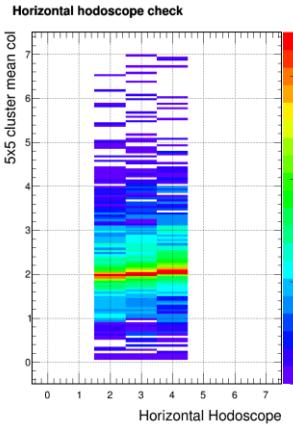




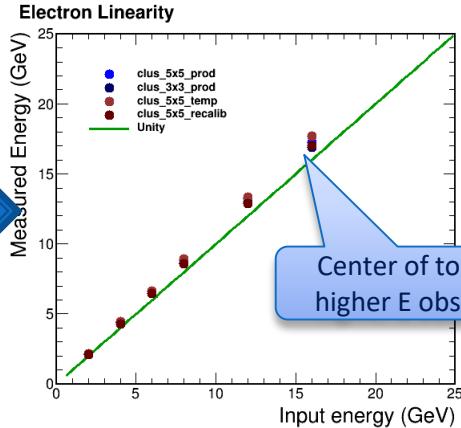
8x8 hodo.



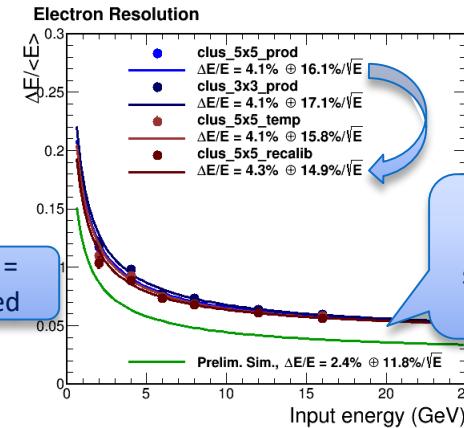
Effect of shower calibration when shower cover many towers



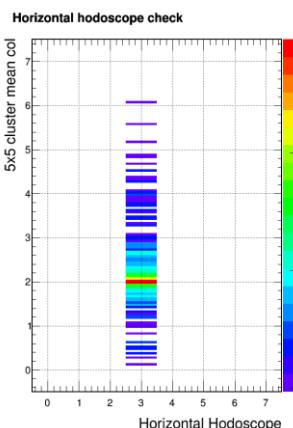
Center 3x3



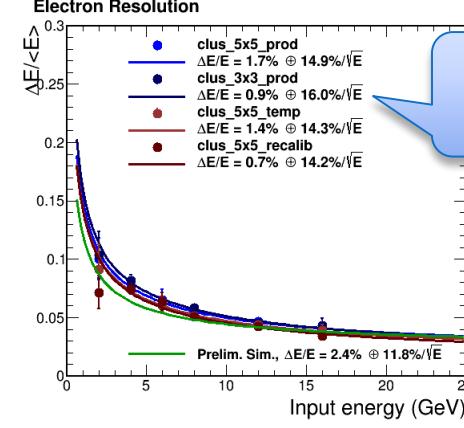
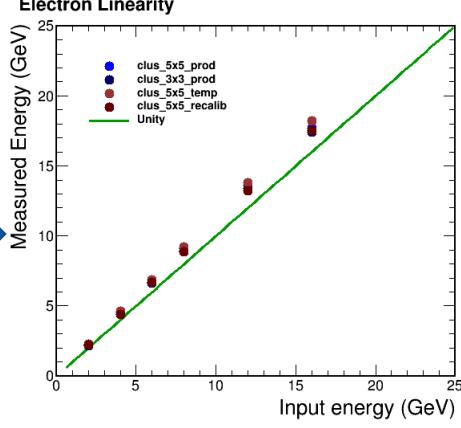
Center of tower = higher E observed



Everything behave similarly when shower around the center of tower



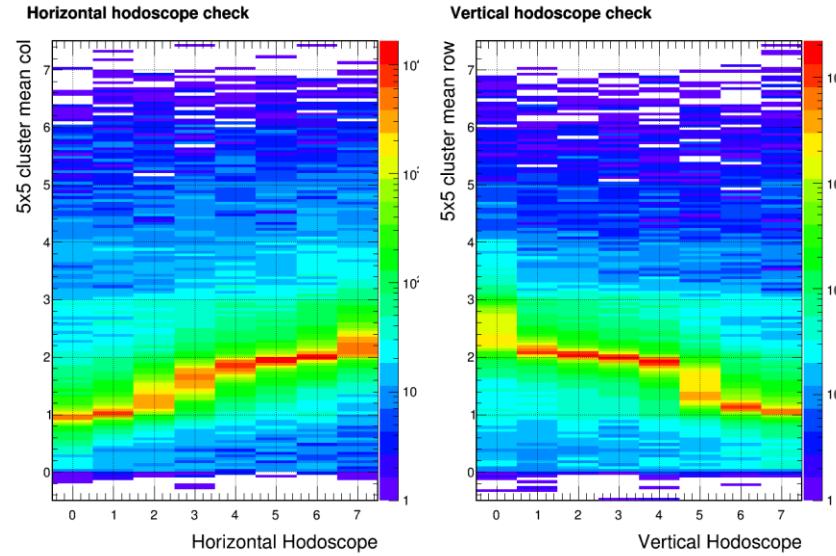
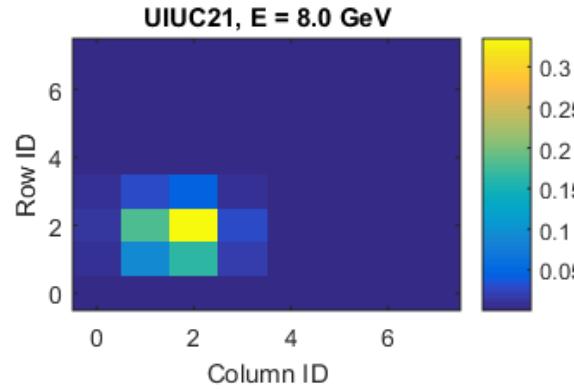
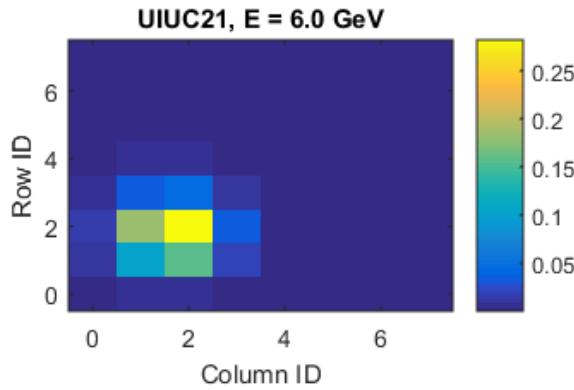
Center 1x1



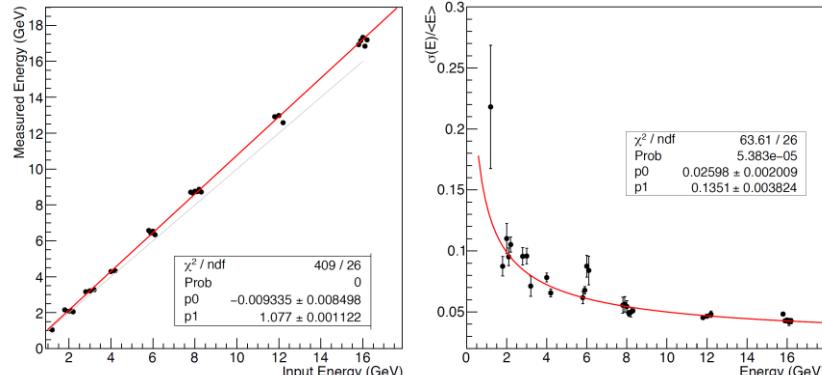
Low statistics leads to low constant term

# Apply to high statistics block21 scan

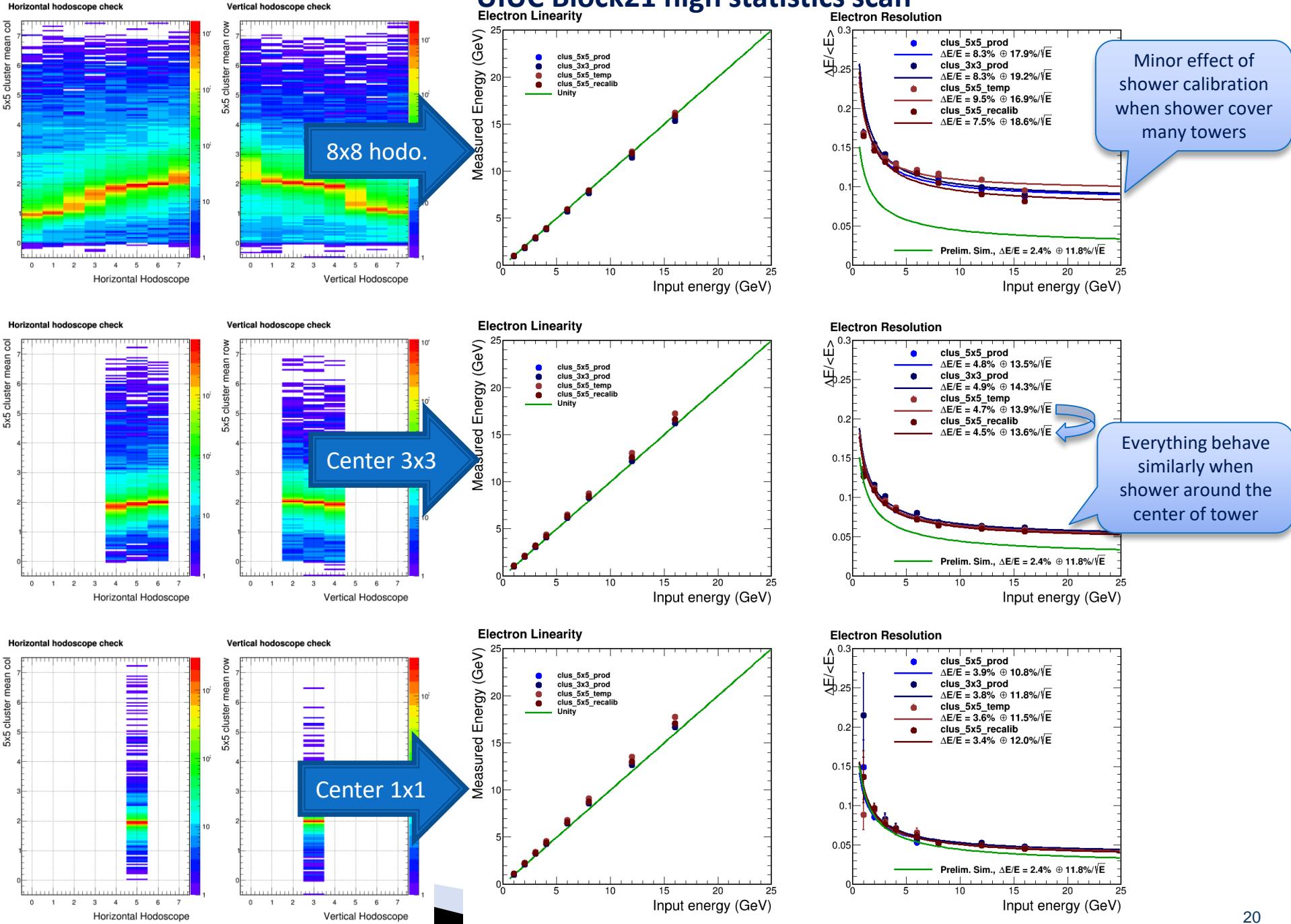
[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28UIUC\\_centered.2C\\_Tower\\_21.2C\\_350k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28UIUC_centered.2C_Tower_21.2C_350k_Events.29)



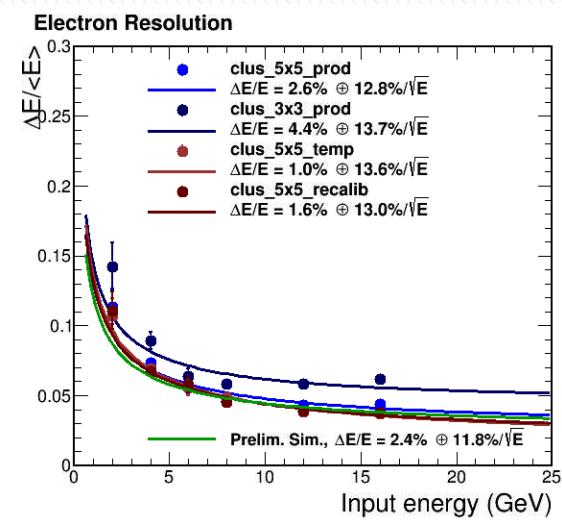
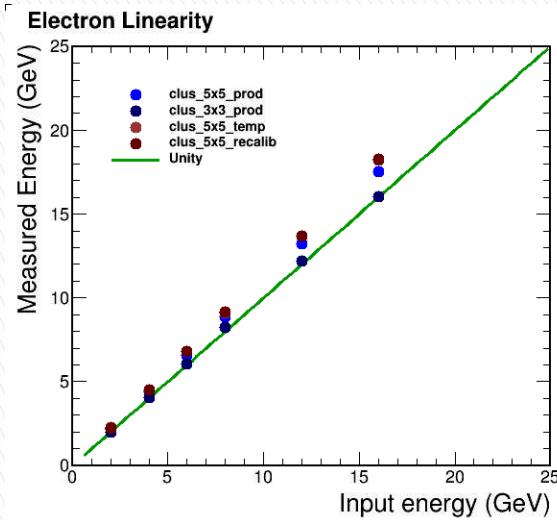
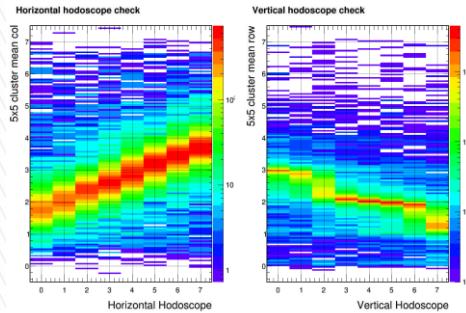
Virginia Bailey (University of Illinois), Dr. Vera Loggins (University of Illinois Urbana Champaign), in 2x1 horoscope finger selection



# UIUC Block21 high statistics scan



# 45 Rotated



Central 2x1 cut